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OCTOBER, 1926

PROGRAM

ELEVENTH ANNUAL MEETING
OPTICAL SOCIETY OF AMERICA

Philadelphia, October 21, 22, 23, 1926

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GENERAL INFORMATION

HOTEL HEADQUARTERS

THE BENJAMIN FRANKLIN HOTEL (Ninth and Chestnut Sts.)

Important. Make your reservations in advance.

MEETING PLACE

THE FRANKLIN INSTITUTE (15 South Seventh St.)

Registration and headquarters at the Franklin Institute.

LUNCHEON

Daily at 12:30 P. M. Arrangements to be announced.

ENTERTAINMENT

The local committee is providing a special program for visiting ladies. This will be announced later and will probably include luncheon at the John Wanamaker tea room, historical sight seeing tours and attendance at some of the special features of the Sesquicentennial Exposition.

HOTEL RATES

The Benjamin Franklin Hotel

Single room with bath, for one	$4.00, $4.50, $5.00, $6.00
Double room with bath, for two (double bed)	$6.00, $7.00, $8.00
Double room with bath, for two (twin beds)	$7.00, $8.00, $9.00
Parlor, Bedroom and bath for one or two	$12.00, $14.00

Please bring this program with you. The number available for distribution at the meeting is limited.

To the Authors of Papers:

The abstracts as reprinted in this program, are subject to the correction of misprints and clerical errors before publication in the minutes of the meeting. If corrections do not reach the Secretary before November 10th, the abstracts will be reprinted in the minutes exactly as they appear in this program.

CONDENSED PROGRAM

THURSDAY, October 21.

9:00 A. M. Registration at the Franklin Institute.
9:30 A. M. Lecture Room of the Franklin Institute.
Papers on Color and Colorimetry.
12:30 P. M. Luncheon
2:00 P. M. Papers on Physical Optics and Spectroscopy.
(Thursday Evening: Theater party being arranged by Dr. Crampton of the local committee.)

FRIDAY, October 22.

9:30 A. M. Lecture Room of the Franklin Institute.
Papers on Radiometry and Photometry.
11:00 A. M. Business Session.
12:30 P. M. Luncheon
2:00 P. M. Invited paper by Professor E. N. Harvey, of Princeton University on "The Production of Light by Living Organisms";
Papers on Physiological Optics.
6:30 P. M. Banquet at the Benjamin Franklin Hotel.
8:30 P. M. Address by Dr. John Miller of Swarthmore College on "The Total Solar Eclipse of 1926". (Lecture Room of the hotel.)

SATURDAY, October 23.

9:30 A. M. Lecture Room of the Franklin Institute.
Papers on Geometrical Optics.

(NO SESSION IS SCHEDULED FOR SATURDAY AFTERNOON.)

THURSDAY, October 21, Morning Session
9:30 a. m. Franklin Institute

Color and Colorimetry

1. William G. Exton, M.D. Laboratory of The Prudential Insurance Company of America

A New Method of Colorimetry.

Because so many reactions give characteristic colors chemists find color measurements increasingly useful, especially in medical and biochemical work with their limitations as to time and sample. Current practice consists in treating at the same time and in the same way as the unknown solution of known concentration which serves as a comparison standard when compared or matched in an instrument of the Duboscq type. This technique is practicable and very useful but has inherent limitations and disadvantages connected with the repeated preparation of comparison standards and their manipulation. These have lately been emphasized by numerous more or less ill-advised efforts to provide permanent standards.

The new method removes all such difficulties by completely eliminating comparison standards. Besides other advantages such as increased range and avoidance of interfering colors, it works with volumes minute enough for micro methods. Very satisfactory results have been had with the colors of different sugar tests on blood and urine with the phenolsulfonophthalein test in the presence of interfering colors of blood and urine, in the estimation of blood hemoglobin and in the determination, without the use of buffers, of the pH of blood.

Since the common logarithm of the reciprocal transmission (color density) is proportional to the depth of the solution measured, its rate of change with depth equals the density at at unit depth, i. e., sensitiveness increases in direct proportion to density. The new method measures color at its greatest density or the frequency most absorbed by isolating the absorption band with a color filter and measuring its intensity by depth or by neutral wedge. Three filters, a red, green, and blue have answered for measuring the concentration of all of the different colors of solutions so far experimented with.

Provisions for the rapid and easy application of the absorption band method have been incorporated in the scopometer which was shown the Society in 1924 for measuring turbidity. In this way the method is practicable with both photometric and extinction criteria. Because the absorption band method is more sensitive, an extinction criterion actually becomes more precise than the photometric comparisons made with the Duboscq as ordinarily used, but with sufficient light and proper filter the Duboscq is improved by combination with the absorption band method.

The present paper will appear in full in J.O.S.A. and R.S.I.

15 min.

2. R. Davis, and K. S. Gibson Bureau of Standards

Reproducible Liquid Filters for the Production of "White Light".

Both for photographic sensitometry and for colorimetry, filters for converting the color of incandescent illuminants (2360°–3000°K) to "white light" (5000°K or mean sunlight) are proving more and more desirable. Such filters, to be of the greatest general value, should be reproducible, permanent of practicable dimensions, and composed of materials readily obtainable.

The glass and gelatine filters, on the market are not considered precisely reproducible nor do they give a resulting energy distribution as close to the ideal as it is possible to obtain with liquid filters. The quartz-nicol combinations are small and relatively expensive.

Previous workers with liquid filters have used a double glass cell, one chamber of which contains an aqueous solution of copper sulphate with or without cobalt sulphate, the other an ammoniacal solution of copper sulphate.

The authors are investigating:

1. The use of a double cell, one part containing an acidulated aqeuous solution of copper sulphate and cobalt sulphate, the other an ammoniacal solution of copper sulphate.

2. A similar cell containing, respectively, an acidulated aqueous solution of copper sulphate and cobalt sulphate, and a pyridine solution of copper sulphate to which mannite is added as a preservative.

A spectral range from 350 to 720 mμ is being studied, and filters are being devised, by altering the concentrations of the components, fore converting the color of sources having color temperatures between 2360° and 3000°K to the color of sunlight and 5000°K. The work may be extended to include other "white" standards.

Very encouraging results have already been attained, particularly in the conversion of acetylene to sunlight color. The questions of permanence and change with temperature are being studied. Integral light transmissions on the basis of standard visibility data will also be computed, so that if the candle power of the source alone is known that of the source and filter combination may be readily obtained.

Bibliography:

R. H. Sinden, J.O.S.A. & R.S.I., *7*, pp. 1125 and 1131; Dec., 1923. (Filter devised by A. H. Pfund.)

J. Guild, Trans. Opt. Soc., *27*, pp. 122–124, 1925–26.

I. G. Priest, J.O.S.A. & R.S.I., *12*, pp. 479–480; May, 1926.

Report of J.O.S.A. Committee on the Unit of Photographic Intensity, J.O.S.A. and R.S.I., *12*, pp. 570–575; June, 1926.

10 min.

3. K. S. Gibson **Bureau of Standards**

A Proposed Method for the Measurement of the Relative Visibility Function.

Consider a two-part photometric field, one part illuminated by heterogeneous light L of standard brightness for heterochromatic photometry, the other part by a mixture of homogeneous light L_λ and heterogeneous light L_m of the same color as L_s. Let the brightness of L_m be variable in a known manner, so that $L_m + L_\lambda$ may be matched in brightness with L_s and L_λ computed. Furthermore, let the color of L_s and L_m be such as to give a good color match with L_λ at the wave length of maximum luminosity. This condition may easily be obtained by filters of high purity.

Under these conditions, as luminosity measurements are made at wave lengths differing more and more from the wave lengths of maximum L_λ, the tendency for the hue difference in the two parts of the field to increase is more or less nullified by the increasing proportion of L_m to L_λ. When, towards either end of the spectrum, L_λ/L_s would otherwise become less than 10 or 20 per cent, L_λ should be increased several fold and the filters coloring L_s and L_m changed accordingly, still keeping L_s at standard brightness level.

If the dividing line of the field is the edge of a polished flicker disk which may be rotated in the usual way for flicker photometry, a means is provided for comparing visibilities by the so-called equality-of-brightness and flicker criteria, under strictly identical experimental conditions, avoiding the tediousness, lack of independence, and variable luminosity of the step-by-step method and the large color differences otherwise necessary.

Advantages of the proposed method thus are:

(1) Luminosity measurements at constant (standard) brightness level.

(2) Greater spectral range at standard brightness level than otherwise possible.

(3) Lower spectrum current, with increased constancy of energy calibration, than otherwise possible.

(4) Much less color difference than when measuring visibility by direct equality-of-brightness photometry. (Also true by flicker photometry but of less importance.)

(5) Undesirable features of step-by-step method eliminated.

(6) Comparison of visibilities by flicker and equality-of-brightness photometry under identical experimental conditions facilitated.

Bibliography:
Studies in the Photometry of Lights of Different Color, H. E. Ives, Phil. Mag., *24*, pp. 149, 352, 744, 845, and 853; 1912.
Visibility of Radiant Energy, Gibson and Tyndall, B. S. Sci. Paper No. 475; August, 1923.
Test of the Additivity of Homogeneous and White Brightnesses, I. G. Priest J.O.S.A. & R.S.I., *8*, p. 198; January, 1924.

10 min.

4. Irwin G. Priest and K. S. Gibson Bureau of Standards & Munsell Research Laboratory

APPARATUS FOR THE DETERMINATION OF THE VISIBILITY OF ENERGY AND THE FUNDAMENTAL SCALES OF VISUAL PSYCHOPHYSICS

The immediate purpose of the present paper is to introdice Dr. Tyndall's paper by describing the apparatus which he used.

This apparatus has been developed from that exhibited at the Washington meeting of the Optical Society, 1922 (J. O. S. A. 7, pp. 99–100). It will be described in its present state and plans for further improvements will be outlined. The cardinal features of the apparatus remain as previously described in the reference just given, but numerous improvements in details have been effected. As now planned, it will provide for the determination of:

1. The visibility of energy

(a) by the "step-by-step" method, or

(b) by comparing the spectral brightness with a constant comparison source, using either equality-of-brightness by juxtaposition or the flicker criterion, or

(c) by a modification of these latter methods as proposed by Gibson, elsewhere in this program.

2. The least perceptible difference in brightness as a function of brightness, wave length, field size, and other incidental variables.

3. The least perceptible difference in wave length *which can not be eliminated by adjustment of purity, or brightness*, as a function of wave length, purity, brightness, etc.

4. The least perceptible difference in purity as a function of wave length, purity, etc.

An outstanding feature of the apparatus is the provision for determining visibility by the different recognized methods *with the same apparatus*. A much more direct comparison of methods will thus be possible. *So far as a comparison of methods is concerned, no measurements of energy are involved.*

In an extensive campaign of determining the visual sensibilities, the advantage of one standard apparatus will be apparent to all who are acquainted with the elaborate calibrations and instrumental corrections incident to such work.

The work carried out by Tyndall has demonstrated the utility of this apparatus to a certain extent. It is intended to maintain the apparatus at the Bureau of Standards for a long period so that other investigations as indicated above, may be expedited.

Bibliography:
"Report of Colorimetry Committee", J.O.S.A. & R.S.I., Aug. 1922.
Priest: J.O.S.A. & R.S.I. *7*, pp. 99–100; 1923.
Priest: J.O.S.A. & R.S.I. *8*, pp. 173–174; 1923.
Jones: Jour. Op. Soc of Am. *1*, pp. 63–77; 1917.
Gibson and Tyndall: B.S. Sci. Pap. 475; 1923.

20 min.

5. **E. P. T. Tyndall** — **Munsell Research Laboratory and Bureau of Standards**

SENSIBILITY TO WAVE LENGTH DIFFERENCE AS A FUNCTION OF PURITY.

Using the apparatus designed by Priest and Gibson, the writer has determined sensibility to wave length difference for his right eye:–

(1) For stimuli of unit purity (spectral light) from 450 to 645 mμ.

(2) For stimuli consisting of artificial noon sunlight plus homogeneous light of some selected wave length, the wave lengths being 455, 470, 481.5, 493, 530, 580, 635mμ, and the purities ranging from unity to a few per cent.

(3) For stimuli consisting of homogeneous light of wave length 455 plus some one of the heterogeneous stimuli specified as follows: (a) equal energy, (b) color temperature 2570°K, (c) color temperature over 24000°K.

(4) For a stimulus consisting of homogeneous light of wave length 530 mμ plus heterogeneous light of color temperature over 24000°K.

The results of 1 are concordant with previous determinations by others. The least perceptible difference (L.P.D.) in wave length for 2 shows, for wave lengths 635, 580, 530, and 493 mμ, at first a slow and then, near zero purity, a rapid increase as purity is decreased. For wave length 455 mμ with decreasing purity, the L.P.D. at first increases and then decreases to a pronounced minimum at about fifteen per cent purity, increasing rapidly beyond this. Wave lengths 470, and 481.5 mμ show a similar but less marked effect.

The experiments noted under 3 and 4 are undertaken in order to study the effect of the spectral distribution of the heterogeneous stimulus in modifying the peculiar results just described for wave lengths less than 482 mμ. It is shown that the form of the curve showing L.P.D. as a function of purity depends upon the spectral distribution of the heterogeneous stimulus.

Two hypotheses are proposed to account for the peculiar results for short wave lengths and a possible criterion for true neutrality of the heterogeneous stimulus is suggested.

Bibliography:
Jones: Jour. Opt. Soc. Am., *1*, pp. 63–77; 1917.
Priest and Gibson: This program (for description of Apparatus).
Priest: J.O.S.A. & R.S.I., *8*, pp. 174–175 (for definition of "purity") J.O.S.A. & R.S.I.

15 min.

6. **I. G. Priest and D. B. Judd** — **Bureau of Standards and Munsell Research Laboratory**

SENSIBILITY TO WAVELENGTH DIFFERENCE AND THE PRECISION OF MEASUREMENT OF DOMINANT WAVELENGTH FOR YELLOW COLORS OF HIGH SATURATION.

Our purpose is to give more definite information than heretofore available on sensibility to wavelength difference, and the *precision* of measurements of dominant wavelength. The "limen" is *not* a discrete quantity. Consider a symmetrically dvided field each half illuminated by the same wavelength and then let the wavelength in one half be changed. For small but finite changes there is *no* change in color. For large differences, there arises a hue difference which is *beyond doubt*. Intermediate differences are "perceptible" in the sense that the observer is *inclined* in the correct direction but is *not certain* a difference exists. Thus, the "limen" is amenable to a probability analysis.

With apparatus already described[1] we have determined:—

(1) The "greatest imperceptible difference" (GID).

(2) The "least difference perceptible *with certainty*" (LPD).

(3) The prob. errors of a single setting for: GID, (r′); LPD, (r″); median settings in which it is attempted to set the mean between "just too long" and "just too short", (r‴). To determine either GID or LPD, the observer makes alternate wavelength settings (with brilliance and saturation matched) on each side of "match". The GID or LPD is taken as ½ the interval.

MEAN RESULTS (from hundreds of observations) for normal trichromats; $\lambda = 575$ mμ; purity = 0.9; 2° circular matching field, divided on vertical diam., 3 to 4 millilamberts; 20° surrounding field, ½ millilambert, artificial sunlight; diam. artificial pupil = 3mm.

Observer	GID	LPD	r′	r″	r‴	GID/r‴	LPD/r‴	LPD/GID
Priest	0.13mμ	0.61mμ	0.12mμ	0.14mμ	0.15mμ	0.9	4.1	4.7
Judd	.24	1.13	.10	.16	.15	1.6	7.5	4.7
Gibson	.18	.70	.11	.16	.12	1.5	5.8	3.9
Tyndall	.28	.71	.12	.12	.20	1.4	3.6	2.5
Skinner	.18	.71	.09	.15	.12	1.5	5.9	3.9
Rudnick	.19	.62	.10	.20	.10	1.9	6.2	3.3
Mean	.20	.75	.11	.15	.14	1.4	5.4	3.8
	From probability analysis					0.8	3.1	4.1

Preliminary determinations by the "method of answers"[2] indicate:—(Tyndall) GID = 0.2 mμ; LPD = 0.6mμ; (Judd) LPD = 0.5 mμ. Tyndall's LPD with different apparatus (brilliance adjusted, purity constant)[3] is 0.53 mμ. Experiments over a period of two months indicate that the LPD for a given observer may vary by a factor of 2.

The values of LPD given above are notably smaller than found by Steindler[4], Jones,[5] and others. They are in substantial agreement with the findings of Rayleigh[6] and Laurens and Hamilton.[7] The above probable errors (r‴) of a single median setting are slightly less than like values computed from Koenig and Dieterici:[8]—Koenig, 0.19 and Dieterici, 0.23 mμ.

Bibliography:

1. Priest: J.O.S.A. & R.S.I., *8*, pp. 173–200; 1924.
2. Priest: B.S. Sci. Pap. *417*, p. 263.
3. Tyndall: "Sensibility to Wavelength . . . ," This program.
4. Steindler: Wien. Sitzb. II A, *115*, pp. 39–62; 1906.
5. Jones: J.O.S.A., *1*, pp. 63–77; 1917.
6. Rayleigh: Proc. Roy. Soc. A., *84*, pp. 464–468; 1910.
7. Laurens & Hamilton: Am. Jo. Physiol. *65*, pp. 547–568.
8. Koenig: "Ges. Abh. Physiol. Optik," pp. 27–29 and Taf. II.

20 min.

7. Irwin G. Priest — Bureau of Standards

AN EXPERIMENT ON COLOR DISCRIMINATION UNDER COMMONPLACE CONDITIONS.

Available data on sensibility to difference in wavelength pertain to the very special conditions of instrumental observation. From the point of view of color discrimination in ordinary experience, such conditions are quite abnormal. I have attempted to obtain, in a particular case an indication of the sensibility under more usual conditions.

The experiment relates to the discrimination of the colors of two yellow glasses having nearly the same spectral transmission, as follows:

Wavelength		380–450	460	480	500	520	540	560	580	600	620	640	660	680	700	720mμ
T	Glass A	0.000	0.003	0.081	0.313	0.540	0.682	0.738	0.735	0.698	0.645	0.602	0.590	0.611	0.629	0.678
	Glass B	.000	.001	.067	.285	.518	.669	.730	.725	.680	.613	.561	.547	.577	.590	.647

Colorimetric characteristics for average noon sun (Abbot-Priest) have been computed as follows:

		A	B
Integral transmission	(Gibson-Tyndall recommended V)	0.632	0.616
Dominant wavelength	(O.S.A. Colorim. Com. basis)	576.0	575.8
Purity	(O.S.A. Colorim. Com. basis)	0.931	0.936

That this *difference* in dominant wavelength is 0.2 mμ has been verified by careful systematic measurements by five trained observers, and by independent computation on the basis of revised values of the excitations.

These glasses were mounted side by side with their edges in contact over a circular hole, 18 mm in diameter, near the center of a piece of gray cardboard (about 20 x 27 cm) so that the

two halves of the hole were covered respectively by the two glasses. The observer held the card about 30 to 40 cm from his eye and looked thru the glasses at a white paper illuminated by daylight. He was thus comparing the colors in a symmetrical two part circular field subtending about 3°. Seventeen observers (normal trichromats) attempted to report the color difference in terms of hue, saturation and brilliance. All showed hesitancy in deciding, and considered the difference (if existant) to be vanishingly small. Several thought the two glasses *might* be identical. However, decisions were finally made as follows:

	For Hue	For Saturation	For Brilliance
Number of observers in accord with objective difference	13	6	10
Number of observers contrary to objective difference	1	8	2
Number of observers quite unable to decide	3	3	5

Bibliography:
"Report of Colorimetry Committee", J.O.S.A. & R.S.I., Aug., 1922.
Jones: Jour. Op. Soc. Am. *1*, pp. 63-77; 1917.
Rayleigh: Proc. Roy. Soc. A, *84*, p. 464; 1910.

10 min.

THURSDAY, October 21, Afternoon Session
2 p. m. Franklin Institute

Physical Optics and Spectroscopy

8. R. T. Birge (Chairman) — **University of California**

REPORT OF THE COMMITTEE ON PHYSICAL OPTICS.

A summary of recent developments.

40 min.

9. Mabel K. Slattery — **Cornell University**
(Introduced by F. K. Richtmyer)

IS THE ABSORPTION OF LIGHT BY SODIUM VAPOR AFFECTED BY THE PRESENCE OF A MAGNETIC FIELD?

The extension of the quantum theory, by Sommerfield and others, to the problem of "space quantization" predicts that, in the presence of a magnetic field, the electron orbits are oriented only in certain directions with respect to the direction of the field, these directions being determined by the total quantum number of the orbit. Thus the orbit of the valence electron of sodium (vapor) in a magnetic field should assume such a direction that the cosine of the angle between the field and the normal to the plane of the orbit should be restricted to the values $+1$ or -1. The experiment of Gerlach and Stern seems to confirm this prediction.

Since, on the quantum theory, absorption of light involves a change of orbit, it seems reasonable to assume that the probability of any interorbital transition should be a function of the angle between the magnetic axis of the atom (when in the magnetic field) and some directional characteristic of the incident quantum—say the electric or magnetic vector. Experimentally, one might expect a change in absorption with a change of angle between the plane of polarization and the direction of the magnetic field.

Polarized light from a sodium flame was passed through a glass tube 6 cm. long containing sodium vapor at 280°C, and placed in a uniform magnetic field, the field being perpendicular to the path of the light. No change of absorption was observed for a field of a few gauss. But with fields of 1000 gauss, there was a slight indication of an *increase* in absorption when the magnetic vector of the polarized light was *perpendicular* to the field.

Although the effect was consistently reproducible, the great difference between the width of the emission and the absorption lines and the limited accuracy of photometric measurements at low intensities combine to make the result somewhat uncertain. The experiment should be repeated under conditions permitting higher precision.

Bibliography:
Sommerfield's "Atombau", fourth edition p. 139 and ff.

10 min.

10. Richard M. Bozorth and F. E. Haworth — **Bell Telephone Labs., Inc., N. Y. C.**

THE CRYSTAL STRUCTURE OF MAGNESIUM PLATINOCYANIDE HEPTAHYDRATE.

The crystal structure of $MgPt(CN)_4 \cdot 7\ H_2O$ has been determined with the aid of spectral and Laue photographs in order to explain if possible some of the peculiar optical properties which these tetragonal crystals exhibit. It is believed that the dichroic polarized fluorescence (rays polarized in the direction of the tetragonal axis are yellow, those polarized perpendicular to the axis are red) is intimately related to the arrangement of the heavy Pt and Mg atoms, which lie in rows parallel to the tetragonal axis. In these rows, Mg atoms alternate with Pt

atoms, and the distance between any two adjacent atom-centers is 1.57A. The shortest distance between rows, however, is 10.3A, 6.6 times the distance between atoms in the same row. Therefore vibrations of the metal atoms probably encounter much greater resistances in the axial direction than in directions perpendicular thereto. Having determined the distance between two positive ions when "in contact" according to W. L. Bragg's hypothesis of atomic radii, and knowing already the distances between many pairs of negative ions, and also between positive and negative ions, the authors distinguish between two commonly used sets of radii, one of which assigns to K^+, e.g., a radius about twice that of Cl^-, the other of which assigns to K^+ a radius not greatly different from that of Cl^-. The first set was proposed by W. L. Bragg in 1920; the second set, consistent with the distance between Mg^{++} and Pt^{++} in $Mg\,Pt\,(CN)_4 \cdot 7\,H_2O$, was proposed by J. A. Wasastjerna, is now adhered to by W. L. Bragg, and has values very close to those proposed by W. P. Davey.

Bibliography:
R. W. Wood, Physical Optics, 2d Ed., 560–561 (1919).
J. A. Wasastjerna, Soc. Sci. Fennica Comm. Phys. Nat. 1, No. 38, 1–25 (1923).
W. L. Bragg, Phil. Mag. [7] 2, 258–266 (1926).
W. P. Davey, Gen. Elect. Rev. 29, 274–287 (1926).

10 min.

11. C. C. Kiess and Harriet K. Kiess — **U. S. Bureau of Standards**

SPECTRAL REGULARITIES FOR Zr II AND Zr III.

The spark spectrum of Zr has been measured at the Bureau of Standards from 2100A in the ultra-violet to 6300A in the red. For many of these lines new measurements of the Zeeman effects have been derived from recent observations made by the late Prof. B. E. Moore of the University of Nebraska. Nearly 50% of these lines, which includes practically all the lines of intensity 3 or greater have been classified as members of the doublet and quartet systems of Zr II, and of the singlet and triplet systems of Zr III. The normal state of Zr I is a^4F. Metastable states of Zr^+ are represented by b^4F, c^4F, a^4P, a^2D, b^2D, c^2D, a^2P, a^2F, a^2G, b^2G, and a^2H. Above these come triads of S, P, D, F, G, and H, terms which combine with the low terms according to the well-known rules. The normal state of Zr III is ^3D. A triad of ^3P, $^3D'$, ^3F, and $^1D'$ terms have been found. Among these terms (and also those of Zr I, which have been established by the authors) are several which are series-forming. These lead to a value of 6.5 volts for the ionization potential of the Zr atom.

Bibliography:
Kiess & Kiess, Popular Astronomy, 31, p. 647; 1923.
Kiess & Kiess, Popular Astronomy, 33, p. 255; 1925.
Meggers & Kiess, J.O.S.A. & R.S.I., 12, p. 427; 1926.
The present paper will appear in full in J.O.S.A. & R.S.I.

10 min.

12. W. F. Meggers — **Bureau of Standards**

STRUCTURE OF THE La II SPECTRUM.

The first regularities in the spark spectrum of lanthanum were discovered by Popow (1) and a number of new levels were recently identified by Goudsmit (2) from the Zeeman-effect observations of Rybar (3). With the aid of additional data on Zeeman effects observed by the late Prof. B. E. Moore, and a comprehensive temperature classification of lanthanum lines by Dr. A. S. King it has been possible to extend the analysis and classify 125 lines with P, D, and F terms in the singlet and triplet systems.

Like Sc II (4) and Yt II, (5) the lines of ionized La appear very prominently in the solar spectrum and it is of interest to compare the structures of these three spectra. The analysis shows that the three spectra are very similar but La II has some distinctive features. The

lowest energy in Sc II and Yt II is represented by $^3D_1$ where in La II it is $^3F_3$. In addition to the terms known for Sc II and Yt II, a second triad of triplet P, D, F terms is found for La II.

Bibliography:
(1) Popow: Ann. d. Phys. 45, p. 163; 1914.
(2) Goudsmit: Kon. Akad. Wet. Amsterdam, 33, no. 8, 1924.
(3) Rybar: Phys. Zeit., 12, p. 889; 1911.
(4) Meggers: Jour. Wash. Acad. Sci. 14, p. 419; 1924.
(5) Meggers and Kiess: J.O.S.A. & R.S.I., 12, p. 417; 1926.

The present paper will appear in full in J.O.S.A. & R.S.I. 10 min.

13. William Mayo Venable **Blaw-Knox Company**

CLASSIFICATION OF LINES OF THE SECONDARY SPECTRUM OF HYDROGEN.

In the "Secondary" spectrum of Hydrogen, over 1100 lines have been measured, of which less than 70 have been hitherto classified into groups, which are:—

(a) Three related series of seven or more terms each, discovered by Richardson and Tanoka.

(b) Five related series of five terms each, known as the First Fulcher Band.

(c) Four related series of four terms each, known as the Second Fulcher Band.

These groups are shown to be sub-divisions of three larger groups, and several hundred additional lines belonging to the large groups have been classified. The group containing the Second Fulcher Band contains altogether 128 lines, all of which are given.

A physical explanation of the origin of these lines is offered.

30 min.

14. Arthur L. Schoen **Research Laboratory, Eastman Kodak Co.**

A PHOTOGRAPHIC METHOD OF SPECTROPHOTOMETRY IN THE RED AND INFRARED.

Following the discovery of Neocyanine, a new photographic sensitizing dye for the red and infrared, photographic spectrophotometry in this region of the spectrum has been simplified considerably. Spectrophotometric apparatus consisting of a prism spectrograph, polarization photometer, and small "high intensity arc lamp" will be described. With this equipment the absorption curves for the Wratten light filters and several photographic sensitizing dyes have been measured from 500 to 900 mμ.

The present paper will appear in full in J.O.S.A. & R.S.I. 10 min.

15. Lewis E. Jewell **Research Laboratory, Eastman Kodak**

AN IMPROVED TYPE OF ILLUMINATION FOR USE IN METALLOGRAPHIC AND MINEROLOGICAL MICROSCOPY.

The paper describes an illuminator adapted for certain kinds of microscopy. The most novel features are a half prolate ellipsoidal hole in a stellite mirror inclined at an angle of 45° to the microscope axis, and a "nose piece" iris diaphragm. The light coming from one side is reflected by the mirror down through one-half of the objective (except the central portions). The result is specular reflection from polished plane surfaces of the object which are perpendicular to the microscopic axis. This light passes back through the outer portions of the other half of the objective. This light irregularly or diffusely reflected from the object passes through the objective, and the hole in the mirror, as well as the unobstructed half of the objective and gives a relief effect. The iris diaphragm limits the intensity of the specular peflection to any desired intensity. The nose piece diaphragm is also very useful where transrarent objects are examined. The advantage of a wide-angled beam of light illuminating the structural detail of the object is retained. Illustrations show detailed plans of the illuminator and photomicrographs are given.

The present paper will appear in full in J.O.S.A. & R.S.I. 15 min.

FRIDAY, October 22, Morning Session
9:30 a. m. Franklin Institute

Radiometry and Photometry

16. B. J. Spence (Chairman) **Northwestern University**

REPORT OF COMMITTEE ON RADIOMETRY AND PHOTOMETRY

A summary of recent developments.

20 min.

17. Arthur C. Hardy and Frederick W. Cunningham Massachusetts Institute of Technology

A METHOD OF CONTROLLING THE INTENSITY OF A SMALL LAMP WITHOUT THE USE OF ELECTRIC MEASURING INSTRUMENTS.

A simple Wheatstone bridge method of controlling the luminous intensity of a small lamp has been devised. This method does not require a galvanometer and should therefore be useful in small portable photometers or exposure meters. Under favorable conditions, the average deviation in intensity of a single setting is less than 2%. A model will be exhibited.

5 min.

18. H. J. McNicholas **Johns Hopkins University and Bureau of Standards**

ON THE USE OF THE INTEGRATING SPHERE IN REFLECTOMETRY.

The photometric integrating sphere has been applied in various ways to the measurement of the ratio of total reflected to total incident light for various diffuse reflecting media. The methods of use proposed by Sharp and Little[1] and by Karrer[2], are tested in this work using a set of samples covering a wide range of glossiness and absolute reflection. In this test, the brightness of the sample under nearly completely diffused illumination from a hemispherical source, is observed for various angles of view from the normal to the surface, and the total reflected light flux computed from these data. The total illumination on the sample is likewise computed from the measured brightness distribution over the hemispherical source.

The brightness of glossy samples is found to increase considerably with increasing angle of view from the normal to the surface, confirming the results of the computations of Walsh[3] and his prediction of large errors in the performance of the sphere.

Bibliography:

1. Trans., I.E.S. 15, p. 802; 1920.
2. B. S. Sci. Pap. No. 415, Aug., 1921.
3. Trans., I.E.S., 18, p. 475; 1923.

15 min.

19. W. B. Rayton **Bausch and Lomb Optical Company**

AN IMPROVED POLARIZATION PHOTOMETER.

Polarization photometers now available are characterized by the fact that it is impossible to graduate them with an accurate density or transmission scale. This is due to the fact that when they are adjusted so that the two fields extinguish at 0° and 90° respectively the match point does not fall exactly at 45°. An instrument will be described in which this difficulty has been eliminated permitting the great advantage to be obtained of making it direct reading.

10 min.

20. F. E. Wright **Geophysical Laboratory**

A New Polarization Photometer Eyepiece.

This device was constructed to serve primarily as an eyepiece on an astronomical telescope for use especially in a study of the amount of polarized light reflected by different parts of the moon's surface under different angles of incident illumination. For this purpose it is essential that the image of the object be viewed at the time the photometric readings are taken. The device consists of a Wollaston prism to one end of which is cemented a negative lens and to the opposite end a positive lens. The two pencils of converging rays from the Wollaston prism pass through a biprism, mounted so as to be movable along the telescope axis, and thence to a second biprism in the image plane of a low power ocular, in front of the lens of which is mounted a rotatable analyzer. On placing the eye at the small exit pupil of the instrument, two images of the object under study are seen, one on each side of the photometric field. The first biprism is moved until the images of any specified point are in juxtaposition; the analyzer is then rotated until the two images are equally illuminated, and from the position of the analyzer the amount of polarized light present is computed. By removing the negative lens from the Wollaston prism the eyepiece is converted into a low power telescope suitable for studying sky polarization and allied phenomena.

10 min.

Business Meeting of the Optical Society at 11:00 A.M.

Election of Treasurer.

Reports of the Council and of Officers of the Society

FRIDAY, October 22, Afternoon Session
2 p. m. Franklin Institute

Physiological Optics

21. Professor E. N. Harvey — **Princeton University**

THE PRODUCTION OF LIGHT BY LIVING ORGANISMS.

(By Invitation)

22. Frank Allen (Chairman) — **University of Mantitoba**

REPORT OF THE COMMITTEE ON PHYSIOLOGICAL OPTICS.

A summary of recent developments.

20 min.

23. Deane B. Judd — **Cornell University**

APPARATUS FOR THE CONTROL OF STATIONARY LIGHT STIMULI

A rotary tachistoscope has been devised in which the episcotister and an electrically controlled, auxilliary shutter both fall close to the focal plane of the illuminating beam. This arrangement accomplishes accurate control of duration. Light from the source lamp passes (1) through a condensing lens system, (2) the shutter system, (3) through a series of diffusing and absorbing screens and illuminates a lantern slide. A same-size image of this slide is projected on a ground-glass screen from behind. This image serves as stimulus for the observer in front of the screen.

The principle advantages of the apparatus are:

(1) A light pulse is produced whose duration is continuously variable between 0.005 and 2.0 seconds. The rise from zero to maximum intensity and the subsequent cut-off of this pulse is so rapid as to be negligible even for the shortest durations.

(2) The intensity of the light stimulus is continuously variable from 0.001 up to 500 ml.

(3) The intensity of the surrounding field is continuously variable from 0.0001 up to 0.5 ml.

(4) A sharp image of any object that can be placed on a lantern slide may be projected as a monocular or binocular stimulus.

The present paper will appear in full in The American Journal of Psychology (January, 1927).

10 min.

24. Deane B. Judd — **Cornell University**

A QUANTITATIVE INVESTIGATION OF THE PURKINJE AFTERIMAGE

The response to a momentary retinal illumination is usually described as a series of images. These images vary widely in number and character with the attributes of the stimulus (intensity, duration, quality) and equally as widely with attendant experimental conditions (surrounding field attributes, retinal region stimulated, state of adaptation of the observing eye to light, etc.). The largest number of images or phases that have been identified in the response to a momentary retinal illumination of moderate intensity is eight, —four bright (positive) phases and four dark (negative) phases. The third bright phase (i. e. the third positive image or second positive after-image) has been designated as the Purkinje afterimage because of its discovery by Purkinje in 1819.

The attributes of the Purkinje afterimage, as described in the literature and checked in the present work, are as follows:

(1) It appears brightest about one-half second after the end of the stimulus.

(2) It is preceded and followed by a dark (negative) phase.

(3) Its hue is characteristically complementary to that of the primary image *when that image possesses a hue.* The Purkinje phase following a white primary image is white.

In the present work a determination has been made of the following quantities:

(1) The smallest stimulus brightness (in photons) which elicits a noticeable Purkinje after image as a function of the duration of the stimulus,

(2) Liminal brightness (same as in 1) as a function of the adaptation of the observing eye to darkness,

(3) The smallest visual angle by which two lines in the stimulus (width of line equal to their separation) must be separated in order to be perceived as distinct in the Purkinje after-image, (This angle was determined as a function both of stimulus duration and of surrounding field intensity.)

(4) The stimulus brightness at which the complementary character of the Purkinje phase was best aroused. This was done for four stimuli of widely different dominant wavelengths.

These results, together with the findings of most other workers, seem to be explicable on the basis of the assumption that nerve activity causes, or is accompanied by, the emission of light of low intensity.

Bibliography:

Fröhlich, F. W., Untersuchung über perio'lische Nachbilder; Zsf. f. Sinnesphysiol., *52*, 60-88, (1921).

The present paper will appear in full in The American Journal of Psychology (April, 1927).

20 min.

25. M. Katherine Frehafer **Goucher College**

PRELIMINARY NOTE ON AFTER-IMAGES FROM STIMULI OF LOW SATURATION AND SHORT DURATION.

Of the three positive after-images usually observed from a stimulus of short duration (.13 second), there is one that is, under the proper conditions, almost complementary in hue to the stimulus. An attempt was made to study the characteristics of this image (the Purkinje, so called) for white and nearly white stimuli. It was thought possible that a white Purkinje image might be observed.

Data were obtained from 10 observers, of whom 6 had had some previous experience in similar work. The circular stimulus used (light from a 1,000 watt lamp, passed through a filter, diffused, and focussed on a ground glass screen) was not uniformly illuminated, but was brighter in the center and fell off to ½ this value at the edge. From such a graded stimulus both the first image and the Purkinje can be viewed simultaneously, a condition that aids the observer in recognizing the Purkinje image and in determining its hue, by comparison with the other.

As a result of this preliminary work, the following facts have been noted. 1. Under the conditions used, the hue characteristics of the after-images showed enormous variation, embracing all the spectrum hues, plus purple. An observer who on first trial reported white images, on subsequent trials became more and more sensitive to the presence of hue. 2. All observers at some time reported blue images, usually of low saturation. There were a few reports of unsaturated yellow from unsaturated blue stimuli; but blue images predominated. Some observers distinguish lavender, purple or violet images, both in place of and in addition to the blue. 3. Although the blue image changes in character as one passes from a yellow to a white to a blue stimulus, it does not seem to become unmistakably white. This method cannot be used, apparently, to determine the stimulus that will evoke the white sensation, unless subsequent work with stimuli of different types yields an image of more distinctive character than any so far obtained.

Bibliography:

See references to previous paper by D. B. Judd.

10 min.

26. Charles Sheard — **Mayo Clinic and Mayo Foundation**

THE SPECTROPHOTOMETRIC ANALYSIS OF THE COLOR OF THE SKIN.

The color of the skin is dependent upon a variety of causes which may in a general way be grouped as due to (a) pigmentation, or melanin, (b) character, amount and distribution of the blood in the capillary bed of the skin. By means of spectrophotometric data obtained by reflection from the surface of the skin and by subsequent analysis into excitation color curves it is possible to draw conclusions of importance in both normal and pathologic conditions. It will be shown that: (1) spectral analyses show that there is a very close agreement in the values of the dominant wavelength, purity and percentages of red, green and violet in normal blondes and brunettes, mulattoes and in such conditions as Addison's disease; (2) in polycythemia, the congestive stage of Raynaud's disease and allied conditions, there are marked departures from normal color curves; (3) cyanosis is noticeable in certain diseases; analysis shows that there is a marked reduction in the summated values of the reds and greens in patients with these conditions as compared with normal persons.

The present paper will appear in full in Archives of Internal Medicine. 15 min.

27. Charles Sheard — **Mayo Clinic and Mayo Foundation**

SPECTROPHOTOMETRIC STUDIES OF BILE PIGMENT.

In this paper the results of recent experimentation, in which spectrophotometry has been employed as the method of examination, will be presented. These infestigations have to do with: (1) the effects of fading and slight degrees of turbidity and hemolysis on the spectrophotometric determination of bilirubin in blood plasma or serum, and other details of technic; (2) the proof of the assertions that (a) bilirubin is formed in the spleen and the bone marrow, (b) that bilirubin is formed from hemoglobin and (c) that hematin appears as an intermediate product in the formation of bilirubin from hemoglobin; (3) that the liver is a site of bilirubin formation. While bilirubin is made in both the spleen and liver, the amount is insignificant as compared with that made in the bone marrow. More bilirubin appears to be made in the spleen than in the liver. The paper will close with a presentation of a spectrophotometric analysis of blood serum in normal and pathological conditions.

15 min.

28. Charles Sheard — **Mayo Clinic and Mayo Foundation**

THE EFFECTS OF ULTRAVIOLET RADIATION UPON GROWTH AND DEVELOPMENT.

The results of a number of experiments will be presented and discussed regarding the influence of radiant energy and of ultraviolet radiation in particular on the periods of incubation, metabolism, growth and life of eggs (frogs, chickens and so forth) when treated and cared for under varying conditions, and upon the germination of seeds and growth of plants. The curves of germination of seeds and the curves of growth under selected filters with normal sunlight and again with ultraviolet radiation (from a Victor X-Ray Corporation mercury arc lamp) have demonstrated that the ultraviolet radiations are conducive to endogenous growth and development, hence to seed germination and root growth, but that the green and yellow portions of solar energy are most conducive to plant growth or exogenous development. Experiments will be described showing the effects of ultraviolet radiation upon hens' eggs, as affecting the periods of incubation and the resistance to disease evidently developed by pre-natal radiation.

15 min.

FRIDAY, October 22, Evening

6:30 p. m. Banquet at the Benjamin Franklin Hotel.

8:30 p. m. Address by Dr. John Miller of Swarthmore College on "The Total Solar Eclipse of 1926," in the lecture room of the Hotel.

SATURDAY, October 23, Morning Session
9:00 a. m. Franklin Institute

Geometrical Optics and Photography

29. Henry F. Kurtz (Chairman) **Bausch and Lomb Optical Company**

REPORT OF THE COMMITTEE ON GEOMETRICAL OPTICS.

A summary of recent developments.

20 min.

30. Arthur C. Hardy **Massachusetts Institute of Technology**

THE OPTICAL SYSTEM OF THE OSCILLOGRAPH AND SIMILAR RECORDING INSTRUMENTS.

A study has been made of the optical system usually employed to record the deflection of a beam of light on a moving strip of film. Expressions have been derived for the exposure on film, the size of spot, and the deflection of the spot for a given rotation of a mirror in a system employing either spherical or cylindrical lenses. By the use of these, it is possible to calculate in advance the performance of any system and to insure sufficient illumination to make the trace visible upon development.

It is shown that the illumination is in all cases limited by the dimension of the mirror normal to its axis of rotation. The dimension of the mirror parallel to this axis affects the illumination only when sperical lenses are used throughout. The importance of using a small deflection together with a spot of corresponding size is demonstrated.

20 min.

31. P. V. Wells **Laboratory of the Prudential Insurance Co. of America**

THE DILUTION LAW IN TURBIDITY MEASUREMENTS.

Tyndallmeters, nephelometers, and turbidimeters are generally used to measure the mass of a precipitate formed under conditions which assure reproducible sizes of particle. The turbidity readings are assumed to be proportional to concentration and depth, but this simple dilution law is followed only over limited ranges. The departures are due to secondary scattering of the light among the particles.

Even when the light is perfectly diffused, the exact geometrical theory leads to a complicated expression for the diffuse density, as shown by Channon, Renwick, and Storr*. A similar theory of the Tyndall intensity of a thick layer of dispersing medium is presented, which shows that the exponential equation of Wilke and Handovsky** is but a first order approximation for high dilutions and small depths. The exact theory is of little use in practise because small cells are used which introduce edge effects. The instruments are therefore limited to interpolation. The empirical calibration curves are linear over dilutions exceeding a hundred fold on double-log-arithmic paper.

Bibliography:

*Phot. J. 58, 121–34, 1918.

**Ann. der Phys. 42, 1145–53, 1913.

10 min.

32. L. E. Dodd (Introduced by F. K. Richtmyer) **University of California, Southern Branch, Los Angeles**

DISTRIBUTION OF THE TOTAL LIGHT INCIDENT UPON AN INFINITE PLANE, FROM AN EXTENDED PLANE SOURCE PARALLEL TO IT.

In measurements on the intensity of the light emanating from non-luminous matt surfaces, the experimental methods usually employed have used for the incident illumination either a

concentrated source, where the beam is made parallel by collimation, or a somewhat extended source at a distance great enough to subtend at any point of the surface a small solid angle. In the present work, accepting Lambert's cosine law, at any rate as suitable here, formulae are obtained by integration for the case of an extended plane source having uniform brightness. The formulae give the intensity distribution for the simpler case of an infinite plane screen placed parallel to the source plane at a distance d from it. The intensity is that of the total light incident at any point of the plane screen. In general, the situation considered is that of a luminous strip with straight parallel edges but infinite length. Particular cases of this are the ones where the bright source field is 1) infinite, 2) semi-infinite (the infinite source plane being divided by a straight line into halves, one bright, the other dark), and 3) a strip of finite width, a. Graphs are drawn and discussed, including 1) semi-infinite field, 10 members of family, d as parameter; 2) bright strip of finite width, 6 members of family, parameter d, and 3) 9 members of family, parameter a; 4) corresponding graphs for a bright strip in an otherwise dark field and a dark strip in an otherwise bright field, 5) resultant intensity distribution of the total incident light for 1, 2, 3, and 4 bright strips of equal width and equal separation, b, and 6) resultant distribution for a large number of parallel equal strips where the dark interspaces have the same width as the bright strips, 5 members of family, parameter d (the strip widths are not taken sufficiently small to involve diffraction; 7) equal strips where d and a are constant, 5 members of family, parameter b; 8) parallel dark strips where d and a are constant, 6 members of family, parameter a; 9) checking of the work on resultant distribution by obtaining the same resultant curve through summing for a); n bright strips, and then b); n dark strips, for a definite value each of a, b, and d.

10 min.

33. Arthur C. Hardy and Fred H. Perrin — **Massachusetts Institute of Technology**

THE SENSITOMETRY OF THE BICHROMATED GELATIN PROCESS.

A sensitometric study has been made of a process wherein Eastman Slow Lantern Plates are sensitized in ammonium bichromate solution, exposed to light, etched in hot water, fixed in hypo to remove the silver halide, washed free from hypo, and dyed appropriately. This process is essentially that described by Mees for the production of colored photomicrographs, and is closely related to many color and photomechanical processes.

The physical theory of the process has been developed and used to predict qualitatively the shape of the characteristic curve and the effect upon this shape of alterations in the conditions under which the operations are conducted. The curve is much like that of a gelatino-bromide emulsion. The conditions studied were concentration of sensitizer, introduction of a light-restraining dye in the sensitizer, time and temperature of sensitization, conditions of drying, time of storage of plates, time and temperature of etching, time of dyeing and acidity of dye.

The details of the method followed and the results obtained cannot be presented satisfactorily in an abstract, but will be fully described in a forthcoming paper.

Bibliography:
Mees, Br. Jour. Phot. Col. Supp. *12*, 1918, p. 1.

15 min.

34. I. C. Gardner and A. H. Bennett — **Bureau of Standards**

THE COMPENSATION OF DISTORTION IN PHOTOGRAPHIC OBJECTIVES FOR AIRPLANE TOPOGRAPHICAL MAPPING.

Lenses to be used in taking airplane photographs for topographic surveying must be very free from distortion. A study of commercial lenses indicates that it is difficult to find lenses satisfactory in this respect. It is shown that in many cases the distortion in a lens may be satisfactorily compensated by a plane parallel plate used as an additional component of the

lens. Data are given showing the effectiveness of the method. It is shown that the addition of the plane parallel plate is generally not detrimental to the other corrections of the objective. Experimental work is reported which justifies these conclusions.

10 min.

35. A. H. Bennett **Bureau of Standards**

THE DISTORTION OF SOME TYPICAL PHOTOGRAPHIC OBJECTIVES.

In connection with an examination of lenses to be used in airplane topographical mapping, a careful study has been made of the distortion of a large number of high grade commercial photographic objectives. The apparatus designed for the measurement of distortion for infinite or finite object distance is described. The data show the distortion of the symmetrical anastigmat when the object is at an infinite distance, and also at unit magnification. At unit magnification, with a symmetrical lens there should be no distortion, but tests show sufficient distortion to affect the performance of the lens. Under this condition the distortion arises from lack of complete symmetry in the lens constuction. Data for the distortion of the unsymmetrical anastigmat (Tessar type) are presented. The results indicate that rather large variations in distortion exist among individual lenses of nominally the same construction. The case in which the axis of the lens is bent, the result of slight prismatic action of the system, is discussed and a method for determining its magnitude is described.

10 min.

36. Otto Sandvik **Research Laboratory, Eastman Kodak Co.**

ON THE RESOLVING POWER OF PHOTOGRAPHIC MATERIALS.

The general practice among more recent workers in measuring the resolving power of photographic materials has been to photograph, in a reducing camera, on the particular material under consideration, some type of test object. Much of this work has been done with a test object consisting of a series of pairs of parallel lines the distance between the centers of which varied. The resolving power is defined to be numerically equal to the reciprocal of the distance, in millimeters, between the centers of the pair of lines just resolved. It has been assumed in some cases that only the periodicity, that is, the distance between the centers of the lines, and and not the relative width of the lines to the separating opaque, was of importance. The present paper describes a new parallel line test object whose ratio of the width of the line to the opaque space varies from 0.40 to 40.0. The results obtained with this test object show a large variation in resolving power depending upon the value of the above ratio. For the range investigated, a linear relationship exists between the resolving power and the logarithm of this ratio.

The lack of agreement between the measurements made with the fan and the parallel line test objects have been due, in part at least, to the fact that the ratio of the line to the space of the former was usually slightly less than unity while that of the latter was frequently much larger.

The present paper will appear in full in J.O.S.A. & R.S.I.

10 min.

37. L. A. Jones, V. C. Hall and R. M. Briggs **Research Laboratory, Eastman Kodak Co.**

ON THE RELATION BETWEEN TIME AND INTENSITY IN PHOTOGRAPHIC EXPOSURE. V.

The effect of different developers and development times has been studied in detail. There is practically no difference in the curves of constant density for developers of widely different characteristics when development is carried to the same point with each developer. A change in development time has no effect on the shape of the curves of constant density

but usually changes the position of optimal intensity. The results support the conclusions that the variation in sensitivity of individual silver halide grains with intensity follows a law very similar to that of the whole emulsion, that all silver halide grains follow the same function, differing chiefly in the intensity for which the sensitivity is a maximum, and that at all intensities a grain is either entirely unaffected by the light falling on it or made completely developable.

The present paper will appear in full in J.O.S.A. & R.S.I.

10 min.

No session is scheduled for Saturday Afternoon